AP Physics 2 summer assignment

AP Physics 2 is an algebra-based physics course that covers the following topics:

Topic	Breakdown	Weighting in AP
Thermodynamics	•Kinetic molecular theory (KMT) •Ideal gas law •Thermal equilibrium •First law of thermodynamics •specific heat and thermal conductivity •Entropy and second law	15-18%
Electric force, fields and potential	•electric charge and force •conservation of electric charge and charging •electric fields •electric potential energy •electric potential •capacitors •conservation of electric energy	15-18%
Electric Circuits	•Electric current •simple circuits •Ohms Law •Electric power •compound DC circuits •Kirchoff's loop and junction rules •RC circuits	15-18%
Magnetism and electromagnetism	•magnetic fields •magnetism and moving charges •magnetism and current-carrying wires •electromagnetic induction and Faraday's Law	12-15%
Geometric Optics	•reflection and images formed by mirrors •refraction and images formed by lenses	12-15%
Waves and physical optics	•properties of wave pulses, waves and periodic waves •boundary behavior •electromagnetic waves •doppler effect •interference and diffraction	12-15%
Modern Physics	•quantum theory, wave-particle duality •Bohr model of the atom •emission and absorption spectra •black body radiation •photoelectric effect •Compton scattering •nuclear decay	12-15%

Summer work topics
- •algebraic manipulation
- •scientific notation
- •dimensional analysis
- •vectors
- •forces

Algebraic manipulation: As an algebra-based course, the ability to manipulate algebraic problems (without external help) is vital for success in this course.

For the following equations, manipulate the formulas to solve for the desired formula. Show all of your work on a separate sheet of paper to receive full credit.

Example problem: $F = \frac{kq_1q_2}{r^2}$ solve for r

$Fr^2 = kq_1q_2$ $\quad r^2 = \frac{kq_1q_2}{F}$

$r = \sqrt{\frac{kq_1q_2}{F}}$

1. $KE = \frac{1}{2}mv^2$ solve for v

2. $q = mc\Delta T$ solve for T_f

3. $T = \frac{2\pi^{\frac{3}{2}}}{\sqrt{Gm_E}}$ solve for G

4. $F_c = \frac{mv2}{r}$ solve for r

5. $v = f\lambda$ solve for f

6. $C = \frac{k\varepsilon_0 A}{d}$ solve for A

7. $R = \rho\frac{L}{A}$ solve for A

8. $n_1\sin\theta_1 = n_2\sin\theta_2$ solve for n_2

9. $n_1\sin\theta_1 = n_2\sin\theta_2$ solve for θ_2

10. $f_o = \frac{v + v_o}{v + v_s}f_s$ solve for f_s

11. $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ solve for f

12. $d\sin\theta = n\lambda$ solve for λ

Scientific notation: many of the calculations in AP Physics 2 require facility with scientific notation. Solve the following problems, showing all of your work.

$$(a \cdot 10^{m})(b \cdot 10^{n}) = (a \cdot b) \cdot 10^{m+n}$$

$$(a^{m})^{n} = a^{m \cdot n}$$

$$\frac{(a \cdot 10^{m})}{(b \cdot 10^{n})} = \frac{a}{b} \cdot 10^{m-n}$$

$$\sqrt[n]{a^{m}} = a^{\frac{m}{n}}$$

Example problem:

$$\frac{(3 \cdot 10^{-6})(2 \cdot 10^{5})^{3}}{(4 \cdot 10^{-3})^{2}} = \frac{3 \cdot 2^{3}}{4^{2}} \cdot 10^{-6+3(5)-2(-3)}$$

$$\frac{24}{16} \cdot 10^{-6+15-(-6)} = 1.5 \cdot 10^{15}$$

1. $$\frac{(6.67 \cdot 10^{-11})(5.97 \cdot 10^{24})(7.3 \cdot 10^{22})}{(3.84 \cdot 10^{8})^{2}}$$

2. $$\frac{(9 \cdot 10^{9})(3 \cdot 10^{-6})(4 \cdot 10^{-6})}{(0.12)^{2}}$$

3. $$\frac{(2.98 \cdot 10^{8})}{(350 \cdot 10^{-7})}$$

Dimensional Analysis: Dimensional analysis is an important tool for showing your work on an AP exam. It is not necessary to show units within the problem. However, your answer MUST include units (or you will not get credit for your answer). If you need to use units to help you set your problem up, do so and don't let pride or vanity make you think you can skip steps.

Example problem: Convert 650 kJ to J

$$650.0\text{kJ}\left(\frac{10^3\text{J}}{1\text{kJ}}\right) = 650.0 \cdot 10^3\text{J} = 6.500 \cdot 10^5\text{J}$$

1. Convert 455 nm to m

2. Convert 4.6 AU to m

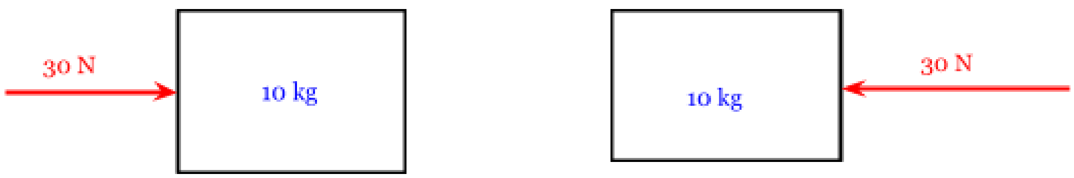
3. 12µC to C

4. MΩ to Ω

Vectors:
Vectors are a way of describing measurements that have both a magnitude (size) and direction. The vector quantity most often used in AP 2 is force. Force must be applied to an object to get it to move. How quickly the object accelerates depends on the **magnitude** of the force that is applied to it. The **direction** of its motion depends on the direction in which the force is applied.

Acceleration is the rate at which an object speeds up, slows down or changes direction (turns).

Vectors are often depicted as arrows. The **length** of the arrow corresponds to its **magnitude** and the direction (from tail to head) corresponds to the direction the force is being applied.



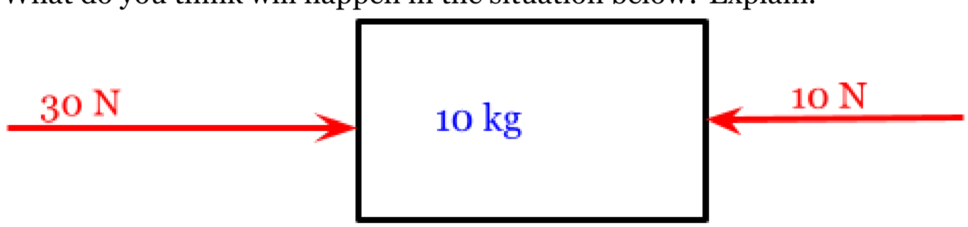
Consider the two boxes above:
Both boxes will be accelerated by the same amount, but the first box will move toward the right, and the second box will move toward the left. (Length of arrow is not exact)

What about the two boxes below? What will be the same? What will be different and why?

Same:

Different:

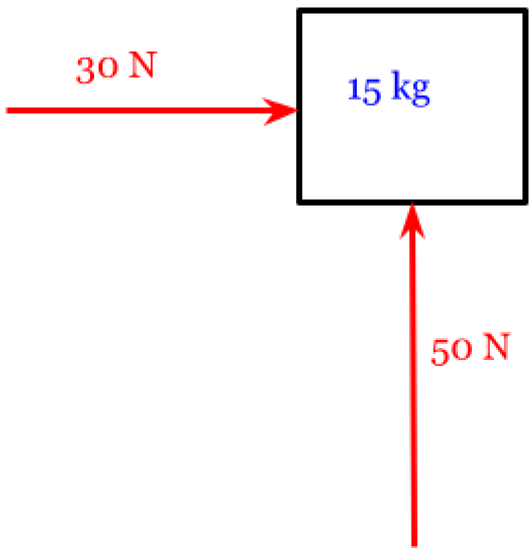
What do you think will happen in the situation below? Explain.



What will happen?

Explanation:

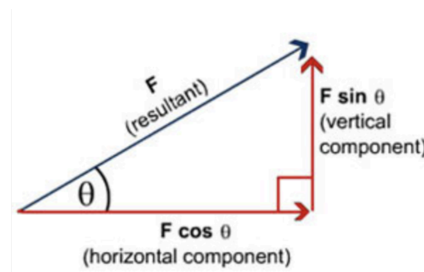
What do you think will happen in the situation below? Explain.



What will happen:

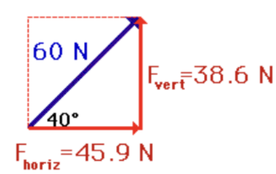
Explanation:

Resolving vectors:
Vectors that are not solely in the x or y direction can be resolved into individual x and y components using trig functions. This is a skill that is used often throughout physics.

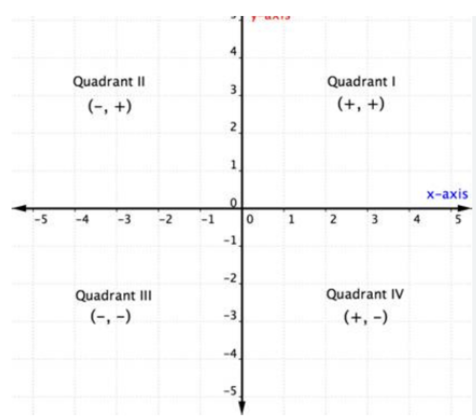


Example: Resolve a 60 N vector that is at an angle of 40° into its x and y components. Whatever units are on the original vector are kept for the components

$$x = 60\cos 40 = 45.9N$$
$$y = 60\sin 40 = 38.6N$$



Resolve the following vectors into the x and y components



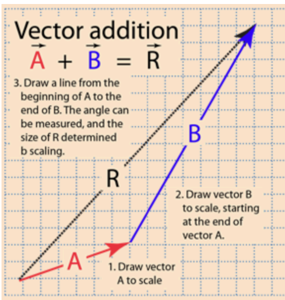
1. 45 m/s at an angle of 20°

2. 3.5 m/s² at an angle of 110°

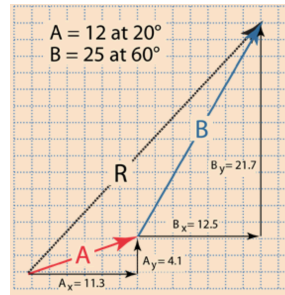
3. 65 N at an angle of 200°

Vector addition:

Vectors can be added together by adding the tail (**__not__** arrow end) of the next vector to the head (arrow end) of the previous vector. The angles given are always as if the x-axis has moved up to the bottom of the next vector. For example, vector B is 25 at an angle of 60°. The 60° is relative to the horizontal line at the foot of the vector.



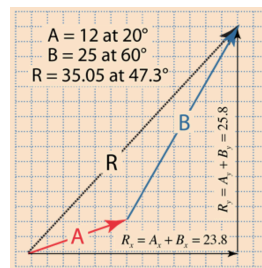
The vector that results from the **sum** of two or more vectors is called the **resultant** A and B are vectors whose sum is the resultant, R.
The magnitude and angle of the resultant can be determined by resolving the individual vectors into their x and y components (diagram to right) and then adding the components together (lower right diagram). The angle can then be determined by using trig rules.



Example problem: Two vectors, 12 N at 20° and 25 N at 60°. Draw the resultant vector and calculate the magnitude and angle of the resultant. (answers given in diagrams)

$$\tan\theta = \frac{\text{opposite}(y)}{\text{adjacent}(x)}$$

$$\tan^{-1}\left(\frac{y}{x}\right) = \theta$$



1. Find the magnitude and angle of the resultant vector when two vectors, 15 N at 30° and 80 N at 50° are added together.

2. Find the magnitude and angle of the resultant vector when two vectors, 60 N at 110° and 90 N at 200° are added together.